consideration. Although the inertia of the water particles is so much greater than that of the surrounding air, yet, in consequence of the viscosity of the air, it does not follow that we may regard the water particles as approximately fixed. I have investigated the corresponding problem of a free spherical obstacle. The results obtained are approximately the same as in the case of a fixed obstacle of same radius a, provided ratio of densities ρ_0/ρ_1 and also $(\rho_0/\rho_1)\,\lambda^{-2}a^{-2}$, λ being wave-length, are small fractions. The former condition is, of course, always satisfied in the case of fogs; the latter condition is satisfied for obstacles of radius 10^{-2} cm., and also for obstacles of radius 10^{-3} cm. when the wave-length of the incident sound is not too great. In the case of obstacles of radius 10^{-4} cm., however, this condition is no longer satisfied; in fact, such small obstacles oscillate to and fro with the air. Hence, when the diameter of the drops of water in a fog is as small as 0·002 mm., such a fog does not interfere appreciably with the propagation of sound, and a result is obtained in agreement with Tyndall's observations.]

The Phosphorescence produced by the α- and β-Rays.

By E. Marsden, B.Sc., Assistant Lecturer and Demonstrator in Physics at the East London College, University of London.

(Communicated by Prof. E. Rutherford, F.R.S. Received and read February 17, 1910.)

The radiations from radio-active substances share with light and other radiations the property of exciting luminosity in various substances. These substances require in general to have a small amount of impurity present,* and in many cases they appear to lose their sensitiveness under the prolonged action of the radiation. Thus Beilby† has shown that barium platinocyanide after continued exposure to the β-rays assumes a reddish-brown colour, while the luminosity excited by the rays falls off considerably. Also it is well known that the zinc sulphide screens of spinthariscopes after a time need renewal owing to their luminosity becoming fainter.

As the experiments of Rutherford and Geiger‡ have shown that the scintillation property of zinc sulphide can be used for quantitative measure-

* Lenard and Klatt, 'Ann. d. Physik,' vol. 15, pp. 225, 425, 633, 1904; also E. Regener, 'Le Radium,' 7, 1, p. 9, January, 1910.

† Beilby, 'Roy. Soc. Proc.,' A, vol. 74, p. 506, 1905.

‡ Rutherford and Geiger, 'Roy. Soc. Proc.,' A, vol. 81, p. 141, 1908.

ments of substances emitting α-particles, it has become of interest to investigate the nature of this effect. The following questions have, therefore, been examined.

Zinc Sulphide.—(1) Effect of continued bombardment of α-particles on the number and intensity of the scintillations produced. (2) Decrease of the total luminosity with continued bombardment. (3) Effect of temperature and infra-red radiation on the luminosity excited by the α-rays. (4) Character of the luminosity and the energy associated with it.

Willemite and Barium Platinocyanide.—(5) Luminosity of willemite exposed to radium emanation. (6) Luminosity of barium platinocyanide exposed to radium emanation.

(7) Phosphorescence of zinc sulphide, willemite, and barium platinocyanide due to β-rays. (8) Comparison of α- and β-ray excitation with that of light.

(1) *Effect of Continuous Bombardment of* α-*Particles on the Number and Intensity of the Scintillations produced.*

An amount of emanation equivalent in γ-ray activity to about 25 mgr. of radium was enclosed in a conical shaped tube fitted with a mica window, which was thin enough to let the α-particles through, and the pencil of α-particles emitted was directed on to a zinc sulphide screen. The scintillations produced by the α-particles from a standard piece of polonium on a definite portion of the bombarded part of the screen had previously been counted by means of a low-power microscope. After the bombardment had been kept up for several hours the tube was taken away and the polonium placed in the same position relative to the screen as before. The scintillations produced on the screen were then again observed, and they were found to have diminished in intensity, while at the same time the number counted per minute was slightly less. The diminution in the intensity of the scintillations was more marked with still more prolonged bombardment, and the decrease in the counted number of scintillations produced by the α-particles from the polonium source was probably due to their diminished intensity resulting in some of them being too weak to be recognised. It was also noticed that the luminosity produced by the pencil of α-particles from the emanation tube was less on the previously bombarded part of the screen than on unbombarded parts. This decrease appears to be due to the decrease in the intensity of each scintillation, and probably only to a small extent, if any, to an actual diminution in the number of scintillations.

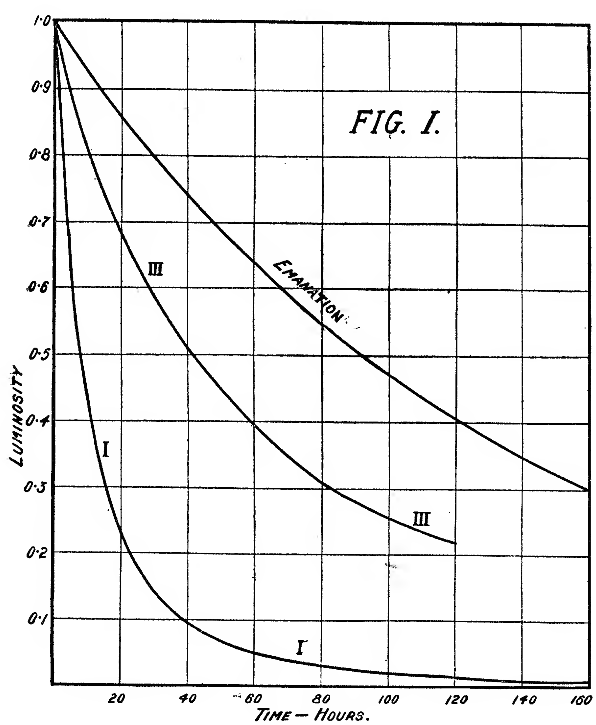
(2) *Decrease of the Total Luminosity with Continued Bombardment.*

To investigate the diminution of the total luminosity more closely the following arrangement was used:—Radium emanation was sealed off in a small tube about 4 cm. in length and 7 mm. diameter, and the luminosity produced was compared by means of a Lummer Brodhun photometer with the illumination from a small standard lamp through a suitably coloured screen. The luminosity was found to increase somewhat for the first three hours owing to the increase in the number of α-particles due to the growth of Radium A and Radium C to equilibrium value. Afterwards the rate of decay was not the same as that of the emanation, but greater by an amount depending on the initial quantity of emanation present. This decay of luminosity was not exponential, but became relatively slower as the decay proceeded. Thus in a case in which the tube initially contained an amount of emanation equivalent in γ-ray activity to 60 milligrammes radium, the luminosity at first fell to half value in eight hours, while after eight days it was falling to half value in about 60 hours. However, the decay of luminosity was always quicker than that of the emanation even after 16 days.

Table I.

Bombardment in α-particles per sec. per sq. cm. of tube.	9×10^8.	2×10^8.	4×10^7.	$2 \cdot 5 \times 10^6$.	$e^{-\lambda t}$ for radium emanation.
Time.	Luminosity.				
Hours.	I.	II.	III.	IV.	
0	1·00	1·00	1·00	1·00	1·00
5	0·63	0·78	0·90	0·925	0·963
10	0·43	0·63	0·82	0·86	0·928
20	0·23	0·44	0·69	0·78	0·861
30	0·142	0·315	0·59	0·71	0·798
40	0·094	0·230	0·51	0·64	0·741
50	0·068	0·185	0·45	0·58	0·687
60	0·052	0·150	0·395	0·53	0·638
80	0·0395	0·100	0·31	0·44	0·549
100	0·0225	0·060	0·255	0·37	0·472
120	0·0168	0·045	0·220	0·31	0·407
140	0·0130	0·035	—	—	0·349
160	0·0105	0·0285	—	—	0·301
200	—	0·019	—	—	0·223
250	—	0·012	—	—	0·153
300	—	0·0085	—	—	0·105
350	—	0·00535	—	—	0·072
400	—	0·0032	—	—	0·050
450	—	0·00215	—	—	0·034

Experiments were made with tubes containing different amounts of emanation, and in every case it was found that the luminosity decayed quicker than the emanation, even when the tube contained an amount of emanation equivalent in γ-ray activity to only 0·19 milligramme radium. In Table I observations are given relating to the decay with time of the total luminosity of various tubes. Times are reckoned in each case from three hours after the emanation was first introduced into the tube, since that is about the time when the Radium A and Radium C are in equilibrium with the emanation. The values given in the table are taken from smooth curves drawn through the points given by the actual observations. In the first horizontal column are given the approximate values of the bombardment of the zinc sulphide by the α-particles from the emanation and products in the tube. Thus in Case I the tube initially contained an amount of emanation equivalent in γ-ray activity to 72 milligrammes radium. The internal area of the tube was 8·2 sq. cm., so that taking the value $3{\cdot}4 \times 10^{10}$* as the number of α-particles expelled per second from 1 gramme radium the initial bombardment is $\dfrac{0{\cdot}072 \times 3 \times 3{\cdot}4 \times 10^{10}}{8{\cdot}2} = 9 \times 10^{8}$ α-particles per square



* Rutherford and Geiger, 'Roy. Soc. Proc.,' A, vol. 81, p. 173, 1908.

centimetre per second, the factor 3 being introduced because of the three α-ray products, emanation, Radium A, and Radium C. In the last column the value of $e^{-\lambda t}$ for radium emanation is given, this being proportional to the amount of emanation present at time t. It was found that the presence of the zinc sulphide did not affect the rate of decay of the emanation to a perceptible extent.

The observations relating to the Tubes I and III are plotted in fig. 1, with the rate of decay of the emanation for comparison.

The exposure of the zinc sulphide to the emanation also destroys its colour and diminishes its power of responding to excitation by light, and thus it appears that there is some chemical change in its nature. If an organic gum is used to attach the zinc sulphide to the glass, there is also a charring of the gum produced, and this latter effect is probably an important factor in the discoloration of the screens of spinthariscopes.

(3) *Effect of Temperature and Infra-red.*

The effect of temperature on the luminosity of the tubes containing emanation and zinc sulphide was studied over a range from 360° C. to the temperature of liquid air. A tube was surrounded by a bath of water and observations of its luminosity were made between 15° and 100° C., and it was found that the luminosity at 100° was about 6 per cent. less than at 15°.

Experiments of a qualitative nature were made as follows:—A tube was placed in an electric furnace and heated to various temperatures up to 360°, when it was rapidly withdrawn and observations of its luminosity made by visual comparison with a similar tube at room temperature. It was found that the luminosity determined in this way gradually diminished with increased temperature. There was, however, some evidence of a rapid initial diminution of luminosity on first withdrawing the tube from the furnace.

On a tube being placed in solid carbon dioxide or liquid air, no decided diminution of brightness could be detected. This result of the effect of cooling is not in agreement with that of Crookes and Dewar,* who found that the scintillations vanished at the temperature of liquid air. The difference in the results is probably due to the different nature of the zinc sulphide employed.†

Since it is known that infra-red radiation has a considerable effect on the

* Crookes and Dewar, 'Roy. Soc. Proc.,' A, vol. 72, p. 69, 1903; see also Pierce, 'Phys. Rev.,' vol. 26, 1908, pp. 312, 454.

† The zinc sulphide used in these experiments was supplied by Mr. F. H. Glew, and was similar to that used by him for his spinthariscope screens.

phosphorescence produced by light, its effect on the luminosity of a tube containing zinc sulphide and emanation was tried. The radiation from a carbon arc was concentrated on the tube, with a thin piece of ebonite interposed to absorb all except the infra-red rays. It was found that the illumination under the infra-red was 5 per cent. less than that without, the original luminosity being recovered on withdrawing the infra-red. This effect of infra-red appears to be much less than that with excitation by light. (See later.)

(4) *Character of the Luminosity and the Energy associated with it.*

It was noticed that the luminosity of the tubes containing zinc sulphide and emanation appeared to become somewhat more blue in colour as the decay proceeded. Spectroscope measurements were therefore made of the luminosity, but no very decided shift of the maximum in the visual spectrum was observed. The visual spectrum of the luminosity gave a single band going from $\lambda = 5920$ to about $\lambda = 4250$, with a poorly defined maximum at about $\lambda = 5150$. The band has a fairly sharp edge at the red end, but shades off gradually at the blue end.

A series of photographs were taken of the spectrum of the luminosity at different times during its decay. With the particular plates used two bands appeared in the photograph, one towards the red end of the spectrum and another towards the blue. In the first photograph the band of longer wave-length appeared of greater intensity than the one of shorter wave-length. In succeeding photographs, however, the band of longer wave-length appeared to have decayed in intensity relative to the band corresponding to shorter wave-length. This change of relative intensity of the bands in the photographs became progressively more marked, pointing to a change in the character of the light with continued bombardment, the decay of luminosity being more rapid for longer wave-lengths. There was also a slight discoloration of the glass walls of the tube, due to the radiations from the emanation, but it did not appear likely that the change of the spectrum could have been wholly due to this cause.

Nichols and Merritt,* in their spectrophotometric investigation of the photoluminescence of zinc sulphide, found that there were two bands in the spectrum, one with a maximum in the green and a much fainter one with a maximum in the violet. It thus appears probable that the vibrating system giving rise to the violet band is differently affected by the α-rays than that giving rise to the green band.

* "Studies in Luminescence, V," 'Phys. Review,' vol. 21, p. 247, 1905.

Experiments were also made on the energy contained in the luminosity of the tubes containing zinc sulphide and emanation, in order to find out what fraction of the energy of the α-particles appears in the form of light energy of the scintillations.* The differential calorimeter method was employed, similar to that used by Rutherford and Barnes† in their determination of the heat given off by radium. The heating effect of the tube was obtained: (1) when it was covered with black paper and (2) uncovered, so that the light could pass through the glass walls of the vessel; the difference between (1) and (2) giving the amount of heat energy contained in the visible radiation. With the tubes used only about 1·5 per cent. of the total energy of the α-particles appeared in the form of light energy. There was, however, considerable absorption of the light in passing through the layer of zinc sulphide, so that the actual percentage will be higher than this value. The mechanical equivalent per candle power of the light came of the same order of magnitude as that found by Drysdale‡ for monochromatic "yellow green" light, viz., 0·13 calorie per second per Hefner candle power.

(5) *The Luminosity of Willemite exposed to Radium Emanation.*

Radium emanation was sealed off in a small tube lined with willemite, as in the case of zinc sulphide considered above. Examined visually, the light emitted gave in the spectroscope a band going from about $\lambda = 5800$ to $\lambda = 4870$, with a somewhat indefined maximum at $\lambda = 5250$. The decay with time of the total luminosity of the tube was measured and a curve was obtained similar in type to those for zinc sulphide. With corresponding bombardments, however, the rate of decrease of luminosity in the case of willemite was not so great as in the case of zinc sulphide; thus, in a case in which the initial bombardment was at the rate of $1{\cdot}3 \times 10^8$ α-particles per square centimetre per second, the decay of luminosity was practically the same as that for zinc sulphide with a bombardment of 4×10^7 α-particles per square centimetre per second. Figures relating to observations on the decay of luminosity are given in Table II, where the columns have the same significance as in Table I. The results are plotted in fig. 2 in a similar manner to fig. 1.

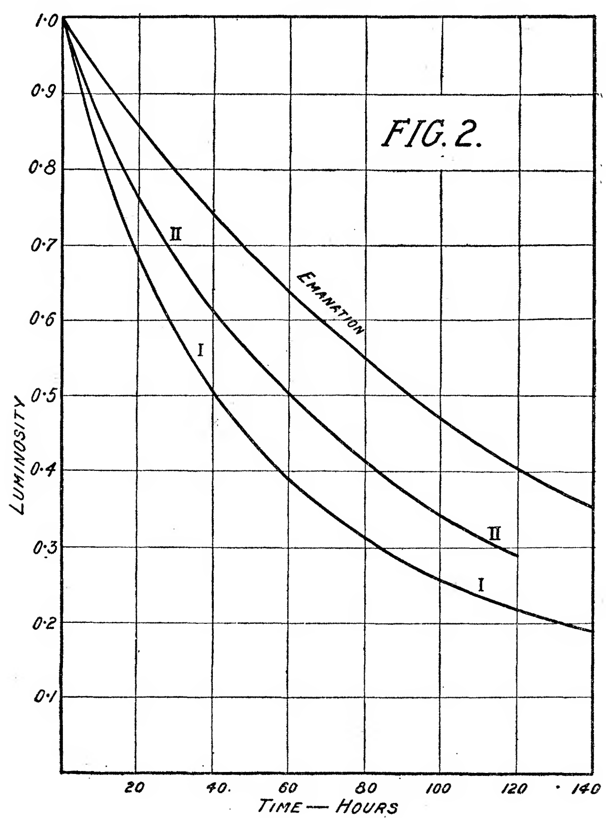
* An investigation of this question was initially the object of this research; the experiments were afterwards extended to the subject of the present paper.

† Rutherford and Barnes, 'Phil. Mag.,' p. 202, February, 1904.

‡ C. V. Drysdale, 'Roy. Soc. Proc.,' A, vol. 80, p. 19, 1907; see also P. G. Nutting, "The Luminous Equivalent of Radiation," 'Bull. Bureau of Standards,' 5, 2, p. 261. 1908.

Table II.

Bombardment in α-particles per sec. per sq. cm. of tube.	$1 \cdot 3 \times 10^8$.	6×10^7.	$e^{-\lambda t}$ for radium emanation.
Time.	Luminosity.		
Hours.	I.	II.	
0	1·0	1·0	1·0
5	0·905	0·92	0·963
10	0·825	0·86	0·928
20	0·69	0·76	0·861
30	0·59	0·68	0·798
40	0·51	0·615	0·741
50	0·44	0·555	0·687
60	0·39	0·505	0·638
80	0·31	0·41	0·549
100	0·255	0·34	0·472
120	0·215	0·28	0·407
140	0·18	—	0·349



(6) *The Luminosity of Barium Platinocyanide exposed to Radium Emanation.*

To obtain the effect of α-ray bombardment on barium platinocyanide, it was not convenient to use the same method as in the cases of zinc sulphide and willemite. With a tube lined with barium platinocyanide and containing an amount of emanation equivalent to only 0·2 milligramme radium, the luminosity had fallen to a small fraction of its initial value in the three hours in which the α-ray products RaA and RaC were attaining their equilibrium values. Consequently, to obtain measurements of the fatigue effect emanation was allowed to attain equilibrium with its products (to RaC) in a tube of about 1·5 cm. diameter over mercury, and a screen of barium platinocyanide was pushed up into the tube through the mercury. A curve of decay of the resulting illumination was obtained similar in general shape to those for zinc sulphide and willemite, except that the greater decay of the luminosity than that of the emanation was very much more marked. Thus with a bombardment of the order of 5×10^7 α-particles per square centimetre per second, the illumination initially fell to half value in 8 minutes. The crystals of the barium platinocyanide were changed to a reddish-brown colour by the bombardment, but on the application of heat, as in the experiments of Beilby with β-rays,* the original yellow colour was restored, while the phosphorescing power was renewed.

(7) *Phosphorescence of Zinc Sulphide, Willemite, and Barium Platinocyanide, due to β-rays.*

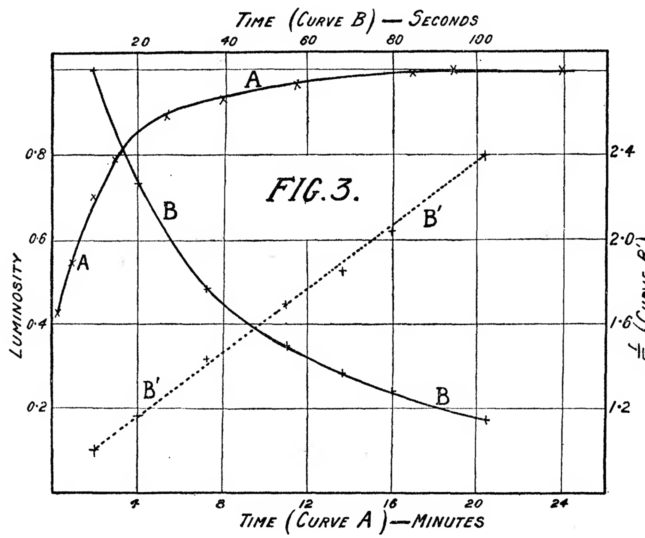
In the foregoing experiments the luminosity was mainly due to the action of the α-rays. It is well known, however, that luminescence can be excited by β-rays. This was investigated as follows :—A small tube of about 7 mm. diameter, with one end open, was lined with zinc sulphide, and inside it was placed a glass tube of the same length, but of smaller diameter, containing emanation which had attained equilibrium with its products as far as Radium C. The amount of emanation was that equivalent to about 25 milligrammes radium, and to reduce it to such small volume it was purified according to the methods developed by Prof. Rutherford.† The glass walls of the tube were of such thickness that all the α-particles from the emanation and its products inside the tube were absorbed by it, but the β-rays could pass through and bombard the screen without suffering any appreciable absorption.

On placing the emanation tube inside the tube lined with zinc sulphide, it

* Beilby, 'Roy. Soc. Proc.,' A, vol. 74, p. 506, 1905.
† E. Rutherford, 'Phil. Mag.,' vol. 15, p. 300, 1908.

was found that at first the illumination gradually increased to a maximum value in about 20 minutes. This is shown in fig. 3 (Curve A), where the ordinates give the values of the luminosity expressed in arbitrary scale.

On withdrawing the emanation tube from the zinc sulphide coated tube, after the illumination had reached its maximum value, the illumination did not cease immediately as might be expected, but took a considerable time to fall to an inappreciable value. This is shown by the continuous Curve B in fig. 3, where the luminosity is plotted against the time after the withdrawal of the β-ray source.



As in the case of the α-ray luminescence, the effect of infra-red on the β-ray luminescence was tried, and it was found that a strong beam of infra-red caused the luminosity to be decreased by 20 per cent., the original illumination being recovered when the infra-red was withdrawn. If the infra-red was put on while the illumination of the screen was decaying, due to the withdrawal of the β-rays, the rate of decay was considerably accelerated, in some cases being fifteen times as rapid.

After the β-ray illumination had increased to its maximum value, its decay with time, with continued bombardment, was quicker than that of the emanation itself. The decay, however, was much less marked than for bombardment by α-rays; thus, after 20 hours' bombardment of an intensity corresponding to all the β-rays from an amount of emanation equivalent to about 2·5 grammes radium per square centimetre of surface, the illumination was reduced by 21 per cent., whereas the decay of the emanation itself was 14 per cent.

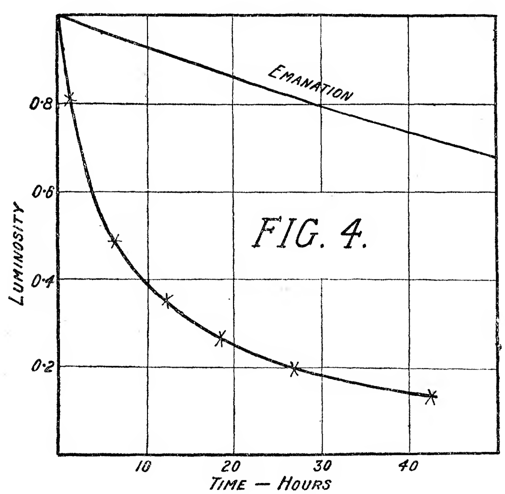
Experiments on the luminosity produced in willemite by the β-rays were

also made with a similar arrangement to that used for zinc sulphide. On applying the β-rays, there was a small rise of about 6 per cent. in illumination to a maximum value after about $1\frac{1}{2}$ minutes. On withdrawing the β-rays, the illumination fell in a fraction of a second to a very small value, and afterwards this small value decayed gradually to zero in about a minute. Strong infra-red was found to have no perceptible effect on the illumination. There was also a fatigue effect of prolonged bombardment of the β-rays of about the same order as that of zinc sulphide.

Observations on the β-ray luminescence of barium platinocyanide were made as in the cases of zinc sulphide and willemite. On application of the β-ray source there was a small initial rise in luminosity of the same order as that in the case of willemite. On withdrawing the β-rays the luminosity fell in a fraction of a second to a very small value and then decayed gradually to zero.

As in the case of willemite, infra-red had very little effect on the illumination. However, with prolonged exposure to the β-rays, the decay of the luminosity for equal bombardments was much more marked than in the cases of zinc sulphide or willemite.

Fig. 4 shows the results of a case in which the initial bombardment per square centimetre of the surface of the barium platinocyanide corresponded



to all the β-particles from an amount of emanation (and products to Radium C) equivalent to about 3 milligrammes radium. With continued bombardment there was a slight reddening effect on the crystals of the barium platinocyanide, but with corresponding bombardments the effect was very much less than that found in the experiments of Beilby (*loc. cit.*). The platinocyanide

used was in the form of small yellow crystals, and was supplied by Messrs. E. Merck for X-ray work.

(8) *Comparison of α- and β-ray Phosphorescence with that of Light.*

The foregoing effects of excitation by β-rays resemble in many respects those found by Nichols and Merritt* for zinc sulphide in the case of excitation by light, and the resemblance becomes even more apparent when we consider the form of the curve of the decay of the illumination after the withdrawal of the exciting β-rays (Curve B, fig. 3). Thus it is found that the curve connecting $1/\sqrt{I}$ and t is practically linear, where I is the illumination at time t after the β-ray source is removed. This is shown in the dotted curve B′, fig. 3, where the ordinates are proportional to $1/\sqrt{I}$. This form of decay curve is the same as that found by Nichols and Merritt in the case of light, and in consequence of this similarity similar experiments to those of Nichols and Merritt were made on the zinc sulphide used in the above experiments. The results obtained were in general agreement with those of the above authors, but differed somewhat from them in degree, probably owing to the different nature of the zinc sulphide employed. Thus it was found that the photo-luminescence decayed in such a way that the curve connecting $1/\sqrt{I}$ and t, where I is the illumination at time t after the exciting rays of light were cut off, was either approximately linear or consisted of two straight lines merging into one another. The rate of decay was found to be largely accelerated by infra-red, while the character of the decay curve with a given excitation was found to depend to a large extent on the previous history and excitation of the zinc sulphide. There was also a saturation effect of duration of excitement somewhat similar to the effect of β-rays (fig. 3, Curve A). These results are strikingly analogous to those found in the case of β-rays, but on the other hand the microscopic examination of a zinc sulphide screen phosphorescing owing to stimulus of light shows a uniform illumination, while in the case of β-rays a somewhat discontinuous undulating effect is seen. A scintillation effect of the β-rays has previously been observed by Regener† in the case of barium platinocyanide. However, if we assume that phosphorescence is an ionisation phenomena, the scintillation effect of the β-rays appears to follow as a natural consequence. The ionisation of electrical dissociation hypothesis was first put forward in the case of photo-luminescence by Wiedemann and

* 'Physical Review,' vol. 23, p. 37, 1906, etc.; see also A. Werner, 'Ann. d. Physik, 24, 1, p. 164, 1907.

† 'Verh. d. Deutsch. Phys. Ges.,' vol. 10, p. 351, 1908.

Schmidt* in 1895, the assumption being that the molecules or groups of molecules of a phosphorescent substance are dissociated by the action of the exciting light into two parts electrically charged, the molecular vibrations due to the recombination of these dissociated ions giving rise to the phosphorescent light. If we further assume that the recombination follow the ordinary law $dn/dt = \alpha n^2$, we get the law of decay of the phosphorescent light $I = k\frac{dn}{dt} = \frac{1}{(a+bt)^2}$, where I is the illumination at time t after the exciting source is cut off. This law has been shown to hold approximately in the cases of excitement by light and by β-rays, and it thus appears probable that some such explanation holds for these two kinds of phosphorescence.

The phenomena of phosphorescence, considered from the point of view of the above theory, have been extensively discussed by Nichols and Merritt in a paper in the 'Physical Review.'† The same authors also made experiments on the cathodo-luminescence of zinc sulphide, and found it to be of very short duration and but little influenced by infra-red.‡ They also found that when the zinc sulphide was subject to relatively intense cathode rays, it underwent a rapid change which was manifested both by a change of colour and by a diminution of intensity of luminescence. These effects are in many respects similar to those of the α-rays, and, on the above hypothesis, may perhaps be explained by the fact that the cathode and α-rays will produce more of an intense surface effect than of a volume effect, as in the case of β-rays or light. It is interesting to note, however, that when the crystals of zinc sulphide are powdered, both the scintillations and phosphorescence are much reduced in intensity. Mr. F. H. Glew has, however, informed me that with powdered diamonds this effect of reduced intensity of the scintillations is not shown.

With regard to the α-ray luminescence, Prof. Rutherford has in the following paper developed a theory to account for the decay of luminosity of substances exposed to the α-rays, and has shown that the experimental and theoretical curves are in good agreement. It is worthy of note, however, that if $1/\sqrt{A}$ be plotted against T, where A is the illumination at time T after the commencement of the bombardment, a curve is obtained which in all the cases considered was approximately linear. This form of curve is strikingly analogous to that for the luminescence produced by the β-rays or by light, but it must be remembered that in the case of β-rays or light the decay refers to the time after the exciting source is cut off, while in the case considered

* 'Ann. d. Physik,' vol. 56, p. 177, 1895.

† "Studies in Luminescence, X," 'Phys. Rev.,' vol. 27, p. 367, 1908.

‡ 'Phys. Rev.,' vol. 28, p. 349, 1909.

above the exciting source is continually acting. The form of the decay curve in this case must only be regarded as empirical, as there appears to be no simple physical foundation for it.

This work was carried out in the Physical Laboratory of the University of Manchester, and I desire to express my gratitude to Prof. Rutherford for his valuable suggestions and his kind interest in the experiments.

Theory of the Luminosity produced in certain Substances by α-Rays.

By E. Rutherford, F.R.S., Professor of Physics, University of Manchester.

(Received and read February 17, 1910.)

In the preceding paper, Mr. Marsden has examined the decay of the luminosity excited by α-rays in zinc sulphide, willemite, and barium platino-cyanide, when subjected to an intense bombardment by α-particles. He has shown that the luminosity decreases with continued bombardment to a very small fraction of its initial value. For a given bombardment, the rate of decay of luminosity is about the same for zinc sulphide and willemite, but is especially rapid in barium platinocyanide. The action of the α-particles on phosphorescent zinc sulphide is of special interest and importance on account of the marked scintillations observed, and the fact that each α-particle under suitable conditions produces a visible scintillation. Mr. Marsden has brought out the essential fact that the actual number of scintillations observed for a constant source of α-rays changes very little with continued bombardment, but the brightness of the scintillations rapidly diminishes.

It is well known that the α-particles exert a marked dissociation effect in complex molecules on which they fall. For example, the α-rays from radium or its emanation, dissolved in water, dissociate the water molecules, producing hydrogen and oxygen at a rapid rate. I have shown elsewhere ('Radio-active Transformations,' p. 253), that the magnitude of this effect is in agreement with the view that each α-particle dissociates as many molecules of water as it produces ions in its path in air. The loss of energy of the α-particle in passing through a gas is mainly used up in producing ions in the gas. The laws of absorption of α-particles, which have been so carefully worked out by Bragg, show that no definite distinction as regards absorption can be drawn between a solid and a gas. It is reasonable to suppose that the α-particle produces ions in a solid as well as in a gas, and that the absorption